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P A T E N T C L A I M S

1. A method of making an elongate spindle member having significant rigidity and stability against pressure and/or tensile loads as well as bending and torsional loads, whereby said spindle member acts between two objects, comprising the steps of

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- winding-up of a plurality of mutually interlocking chain links (1, 12) under axial displacement in a helical winding (5, 16) to form said elongate spindle member,
- using chain links formed with a substantially circular curvature on their exterior sides and including associated engagement means,
- drivingly connecting said chain links to a rotatable driving device (3, 4; 15, 26) arranged in a winding guide means (14) connected with one of said two objects,
- guiding said chain links during rotation of said driving device in said winding guide means so that the chain links are interconnected and retained in engagement by their associated engagement means with neighbouring chain links in the same turn as well as adjacent chain links in neighbouring turns of said elongate spindle member, and
- coupling the helical winding with the other of said two objects by means of a coupling member (6, 18).

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2. A method according to claim 1, characterized by the use of a reversibly rotatable driving device (3, 4; 15, 26) as said driving device to increase and reduce the length of the spindle member by rotation of said driving device in one and the other direction of rotation, respectively.

3. A method according to claim 2, characterized in that the coupling by means of said coupling member (6, 18) is effected by connection with the first produced turn of the helical winding.

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② 4. A method according to claim 2 ~~or 3~~, characterized in that two elongate spindle members (57, 58; 67, 68) are formed by winding-up individual coherent sets of chain links (59, 60) in two helical windings with opposite pitch directions (65, 66), the winding guide means of said sets of chain links being connected with one and the other of said two objects, respectively.

③ 5. A method according to claim 3 ~~and 4~~, characterized in that the two helical windings (57, 58) have the same diameter and that coupling members (63, 64) connected with the first produced turn (61, 62) of each winding are connected with each other intermediate said two objects.

④ 6. A method according to claim 2 ~~and 4~~, characterized in that one of said helical windings (67) are advanced inside the other (68) and have chain links provided with an external threading (69) to engage an internal threading (70) in the chain links of the other helical winding to enable each of said helical windings to function as a coupling member for the other helical winding.

⑤ 7. A method according to claim 2 ~~or 3~~, characterized in that a single spindle device is formed by winding two separate sets of chain links (76, 77) in alternating turns in the same helical winding, both sets of chain links (72, 73) being supplied to the same winding guide means.

⑥ 8. A method according to ~~any of claims 2 to 7~~, characterized by its use in a raising/lowering device for mutual height displacement of the two objects.

⑦ 9. A method according to ~~any of claims 2 to 7~~, characterized by its use as an operator device for opening and closing windows or doors, in

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~~which said two objects are constituted by a stationary frame structure and an openable sash structure.~~

10. A method according to any of claims 2 to 7, characterized by its use as a drilling instrument, said coupling member being connected with a drill or cutter head.

11. A method according to any of claims 2 to 7, characterized by its use for reversible mutual displacement of telescopically connected tube members.

*a*  
12. An apparatus for carrying out the method according to ~~any of the preceding claims~~, characterized in comprising, in connection with one of said two objects, a chain storage (10) with an elongate chain (11) of interlocking chain links (12) having a substantially circular curvature on their exterior sides and including associated engagement means, a guide means (13) for advancing the elongate chain (11), a winding guide means (14) connected with the advancing guide means (13) and comprising a guide (22) for engagement with a guide member (34) on the chain links for winding said helical winding (16), a rotatable driving device (3,4;15,26) arranged in said winding guide means (14) for axial advancement of the spindle device produced by the helical winding (5) and a coupling member (6,18) for coupling the helical winding with the other of said two objects.

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13. An apparatus according to claim 12, characterized in that said coupling means comprises a coupling member (6, 18) connected with an end turn of the helical winding.

14. An apparatus according to claim 12 or 13, characterized in that the chain storage (10) comprises an elongate track connected with the ~~advancing guide means (13) for receiving the chain (11)~~

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which said two objects are constituted by a stationary frame structure and an openable sash structure.

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10. A method according to ~~any of claims 2 to 7~~, characterized by its use as a drilling instrument, said coupling member being connected with a drill or cutter head.

11. A method according to ~~any of claims 2 to 7~~, characterized by its use for reversible mutual displacement of telescopically connected tube members.

12. An apparatus for carrying out the method according to any of the preceding claims, characterized in comprising, in connection with one of said two objects, a chain storage (10) with an elongate chain (11) of interlocking chain links (12) having a substantially circular curvature on their exterior sides and including associated engagement means, a guide means (13) for advancing the elongate chain (11), a winding guide means (14) connected with the advancing guide means (13) for winding said helical winding (16), a rotatable driving device (3,4;15,26) arranged in said winding guide means (14) for axial advancement of the spindle device produced by the helical winding (5) and means for coupling the helical winding with the other ~~or~~ said two objects.

13. An apparatus according to claim 12, characterized in that said coupling means comprises a coupling member (6, 18) connected with an end turn of the helical winding.

*a*  
14. An apparatus according to claim 12 ~~or 13~~, characterized in that the chain storage (10) comprises an elongate track connected with the advancing guide means (13) for receiving the chain (11) in its entire length.

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15. An apparatus according to claim 12 ~~or 13~~,

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characterized in that the chain storage is constituted of a winch connected with the advancing guide means, on which winch the elongate chain is wound.

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16. An apparatus according to ~~any of claims 12 to 15~~ characterized in that the winding guide means (14) comprises a substantially part-cylindrical wall (21), on the interior side of which a guide (22) is provided for engagement with a guide member (34) on the chain links (12).

17. An apparatus according to claim 16, characterized in that which said guide is designed as at least one thread-rib (22) with a predetermined pitch across part of the interior side of said part-cylindrical wall (21).

18. An apparatus according to claim 17, characterized in that the advancing guide means (13) comprises a substantially linear guide rail (20) for controlled advancement of the chain links (12) towards the winding guide means and a guide surface (19, 24) for the exterior side (32) of the chain links, which guide surface is connected substantially in a tangential plane with the interior side of the part-cylindrical wall (21) of the winding guide means, said guide surface (19, 24) having near its connection to said interior side at least one advancing guide member (25).

19. An apparatus according to claim 18, characterized in that the advancing guide member (25) comprises a member protruding from the advancing guide surface (24) for introducing each chain link (12) into the winding guide means (14) with an axial displacement component.

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20. An apparatus according to ~~any of claims 16 to 19~~ characterized in that the drive means

Claim 16

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comprises an advancing wheel (26), which is provided in a peripheral surface with a number of oblique teeth (27) having a predetermined second pitch directed opposite to the pitch of said thread-rib (22), said advancing wheel being journalled coaxially in the winding guide means (14) for engagement with the chain links (12) and being connected with a drive wheel (15) coupled to drive means via a transmission.

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*a* 21. An apparatus according to claim 13 and any of ~~claims 16 to 20~~, characterized in that said coupling member (18) is designed as a substantially disc-shaped cover member with a substantially circular edge surface (51), in which a guide member (52) is provided for engagement with said guide (22) in the winding guide means (14), whereas the cover member is provided, on one side surface (53), with protruding engagement means (54) for engagement with each their respective chain link (12) in the first turn (17) formed in the helical winding (16).

22. An apparatus according to claim 21, characterized in that said protruding engagement means (54) comprises a hook member (55).

*Q* 23. An apparatus according to claim 21 or 22, characterized in that said protruding engagement means (54) comprises a groove (56).

*a* 24. An apparatus according to <sup>Claim 21</sup> ~~any of claims 21 to 23~~, characterized in that said guide member on the edge surface (51) of the coupling member (18) comprises a track (52) for receiving said thread-rib (22) in the winding guide means.

*a* 25. An apparatus according to <sup>Claim 12</sup> ~~any of claims 12 to 24~~, characterized in that the helical winding (5) formed by the winding of the chain links (1) is surrounded by a casing (8) of variable length.

26. An apparatus according to claim 25, ch a -

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characterized in that said casing is a bellow.

*a* 27. An apparatus according to ~~any of claims 12 to 26~~ <sup>Claim 12</sup>, characterized in that a chain storage, advancing guide means and winding guide means are provided in connection with each of said two objects for producing two elongate spindle members (57, 58; 67, 68) by winding-up of two helical windings with opposite pitch directions.

*a* 28. An apparatus according to claims 13 and 27, characterized in that the two helical windings (57, 58) have the same diameter and that coupling members (63, 64) connected with the first produced turn (61, 62) of each winding are connected with each other intermediate said two objects.

*a* 29. An apparatus according to claim 19 and claim 27, characterized in that one of said helical windings (67) are advanced inside the other (68) and have chain links provided with an external threading (69) to engage an internal threading (70) formed by said helical track in the interior side of the chain links of the other helical winding (68) to enable each of said helical windings to function as a coupling member for the other helical winding.

*a* 30. An apparatus according to ~~any of claims 12 to 29~~, characterized in that a single spindle device (75) is formed comprising a helical winding of alternating turns of chain links (76, 77) supplied from two separate sets of chain links.

*a* 31. An apparatus according to ~~any of claims 12 to 30~~, characterized by its use in a raising/ lowering device for mutual height displacement of the two objects.

*a* 32. An apparatus according to ~~any of claims 12 to 30~~, characterized by its use as an operator device for opening and closing windows or doors,

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in which said two objects are constituted by a stationary frame structure and an openable sash structure.

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33. An apparatus according to ~~any of claims 13 to 20~~, characterized by its use as a drilling

instrument, said coupling member being connected with a drill or cutter head.

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34. An apparatus according to ~~any of claims 12 to 20~~, characterized by its use for reversible mutual displacement of telescopically connected tube members.

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35. An elongate chain comprising interlocking chain links (12) with associated engagement means for use in an apparatus according to ~~any of claim 12 to 34~~, characterized in that each chain link (12) has a substantially circular curvature on its exterior sides and, in unfolded projection, substantially the shape of a parallelogram with a first pair of engagement means (43, 44) for connection with neighbouring chain links in the same turn of the helical winding provided at a first pair of opposite sides (28, 29) and further engagement means (49, 50) for engagement with corresponding engagement means on adjacent chain links in neighbouring turns of the helical winding provided at a second pair of opposite sides (30, 31).

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36. A chain according to claim 35 for use in an apparatus according to claim 17, characterized in that each chain link (12) is in its exterior side (32) with a track (34) adapted to receive said thread-rib (22) in the winding guide means, said track forming with said first pair of opposite sides (28, 29) an angle (v) adapted to said predetermined pitch.

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37. A chain according to claim 36 for use in an apparatus according to claim 18, characterized in that an interior side (33) of each chain

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links (12) is formed with engagement means (45) for engagement with the substantially linear guide rail (20) in the advancing guide means (13) and that said exterior side of each chain link (12) is provided with 5 a second guide member (35) for introducing the chain link (12) into the winding guide means (14) with an orifice (38) of said track (34) orientated towards a first end (23) of said thread-rib (22), said orifice opening in the downstream side (28) of said first pair 10 of opposite sides with respect to the direction of advancement.

38. A chain according to claim 37, characterized in that said second guide member (35) comprises a second track provided in said exterior side 15 and ending in said first pair of opposite sides (28, 29) in track orifices (36, 37) displaced in a direction parallel to said first pair of sides (28, 29).

39. A chain according to <sup>Claim 35</sup> ~~any of claims 35 to 38~~ ~~for use in an apparatus according to claim 20~~, characterized in that a guide member (39) is 20 formed in an interior side (33) of each chain link (12), said guide member (39) being designed as a helical track which on the interior side of the helical winding (16) formed by the chain links forms a number 25 of coherent helical tracks (42) with said second pitch for engagement with individual ones of the oblique teeth (27) of the advancing wheel (26) of said driving device.

40. A chain according to claim 37, characterized 30 in that said engagement means (45) form part of a second pair of engagement means (45, 47) provided at said first pair of opposite sides (28, 29) and being brought into engagement with opposite means on neighbouring links in the same turn (17) by the 35 winding of the chain links, to retain the chain links

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(12) in their positions in said winding.

41. A chain according to <sup>Claim 35</sup> ~~any of claims 35 to 40~~  
~~for use in an apparatus according to claim 22, char~~  
~~a c t e r i z e d in that the first pair of engagement~~  
5 ~~means for each chain link (12) comprises a hook-shaped~~  
~~hinge member (44) and a curved track (43) for receiving~~  
~~said hinge member (44), respectively, said curved track~~  
~~(43) being adapted to receive the hook member (55) of~~  
~~said coupling member (18).~~

10 42. A chain according to claim 40 and 41 ~~for use~~  
~~in an apparatus according to claim 18, char a c -~~  
~~a c t e r i z e d in that said second pair of engagement~~  
~~means for each chain link (12) comprises as a fork~~  
~~member (45) provided at a free edge of a wall portion~~  
15 ~~defining said curved track (43) for engagement, on one~~  
~~hand, with said guide rail (20) in the advancing guide~~  
~~means (13) and, on the other hand, with a rib member~~  
~~(47) provided in an interior side of said hook-shaped~~  
~~hinge member (44), said fork and rib members (45, 47)~~  
20 ~~preventing mutual displacement of neighbouring chain~~  
~~links in the same turn in the axial direction of the~~  
~~helical winding by engagement with a rib member (47)~~  
~~and a fork member (45), respectively, on each of~~  
~~respective neighbouring chain links, the hook-shaped~~  
25 ~~hinge member (44) being provided, on each side of said~~  
~~rib member (47), with abutment surfaces (48a, 48b)~~  
~~serving as stop for branches (45a) of said fork member~~  
~~(45) for retaining neighbouring chain links in a~~  
~~predetermined angular position in said turn.~~

30 43. A chain according to claim 42, char a c -  
~~t e r i z e d in that said mutually engaging fork and~~  
~~rib members (45, 47) are positioned in such a way~~  
~~relative to one another that said curved tracks (43) on~~  
~~a chain link (12) are brought into engagement with~~  
35 ~~hook-shaped hinge members (44) in chain links posi-~~

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tioned side by side in the same turn and a neighbouring turn.

Claim 35

44. A chain according to ~~any of claims 35 to 43~~ for use in an apparatus according to claim 23, characterized in that said further engagement means comprises a track (49) in the exterior side (32) of the chain link (12) and a rib member (50) along one side and the other, respectively, of said second pair of opposite sides (30, 31), said rib member (50) being adapted to engage the groove (56) on said coupling member (18).

Claim 35

45. A chain according to ~~any of claims 35 to 44~~, characterized in that each chain link (12) has a length different from an even fraction of a circle having the radius of said helical winding.

46. A chain according to claim 45, characterized in that the length of each chain link (12) constitutes an odd fraction of a circle.

47. An apparatus according to claim 46, characterized in that the length of each chain link (12) constitutes a fifth of the peripheral length of the interior wall side of the winding guide means (14).

Claim 35

48. A chain according to ~~any of claims 35 to 47~~, characterized in that the chain links (12) are moulded from plastics material.

Claim 35

49. A chain according to ~~any of claims 35 to 47~~, characterized in that the chain links (12) are made as cast or sintered metal bodies.

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